

HYBRID TECHNIQUES FOR PAPR REDUCTION OF OFDM SIGNAL

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ABSTRACT

In this paper, we propose an efficient hybrid scheme, which is combination of modified selected mapping and companding methods to reduce high peak-to-average power ratio (PAPR) in orthogonal frequency division multiplexing (OFDM) systems by using the standard arrays of linear block codes (LBC) along with distortion companding technique. Our scheme may be regarded as a modified version of the selective mapping (SLM) i.e. Modified selective Mapping (MSLM), after selecting lower PAPR sequences from MSLM and then these sequences sent through μ -law compander for better reduction of PAPR. In this paper we have investigated hybrid techniques in terms of PAPR reduction and BER.

KEYWORDS: Orthogonal Frequency Multiplexing, Power Amplifier, Peak –To –Average Power Ratio, Selective Mapping, Modified Selective Mapping And Bit Error Rate

INTRODUCTION

With the advancement in technology and user's demands, there has been exponential growth in the field of communications. Increased use of radio spectrum has impacted the reliability of signal transmission systems, forcing the industry to look for better techniques.

Next generation mobile systems are expected to provide substantially high data rate to meet the requirements of futuristic high performance multimedia applications. The minimum target data rate for the 4G system is expected to be around 10-20 Mbps for stationary receivers and at least 2 Mbps for moving receivers. To provide such high data rate with high spectral efficiency newer modulation schemes need to be decided. A promising modulation technique that is increasingly being considered by 4G community for transmitting large amounts of digital data over radio waves is Orthogonal Frequency Division Multiplexing (OFDM). Hence, single carrier systems are being replaced by multi carrier system [1-2].

One major disadvantage of OFDM is that the time domain OFDM signal which is a sum of several sinusoids leads to high peak to average power ratio (PAPR), leading to inefficient use of Power Amplifier (PA) and spectrum. We can reduce undesirable PAPR and many state of art techniques have been proposed to reduce PAPR.

Clipping is the simplest way to reduce the PAPR. The peak amplitude is limited to a desired maximum level by clipping any signal that exceeds the desired maximum [3-5]. Thus the peak power can be reduced and PAPR reduced at the cost of increase in BER due to in-band and out-band spectral regrowth [17-18].

Over a decade researchers have utilized another approach based on coding techniques by selecting lower PAPR using shorter Hamming distance [6-8]. Yan Jie and et. al [7] have been proposed modified SLM based on standard array Linear Block Codes (LBC), it is observed that performance in reducing the PAPR by 5.5 dB.

We proposed novel technique to reduce PAPR by using combination of modified SLM and companding technique regarded as hybrid technique.

BASICS OF PAPR

The PAPR of OFDM is defined as the ratio between the maximum instantaneous power and the average power, defined by

$$PAPR = \frac{\max_n \{x[n]^2\}}{E_n \{x[n]^2\}} \quad (1)$$

Where $E[\cdot]$ denotes expectation operator and $x[n]$ is the discrete time domain samples.

OFDM signal can be expressed as using IDFT/ DFT

Now consider a data sequence; $x[0], x[1], \dots, x[N-1]$,

$$x[k] = \frac{1}{N} \sum_{i=0}^{N-1} x[i] \exp\left(\frac{j2\pi ki}{N}\right) ; 0 \leq i \leq N-1 \quad (2)$$

$$x[k] = \frac{1}{N} \sum_{i=0}^{N-1} x[i] \exp(j2\pi f_i t_k) \quad (3)$$

Where $f_i = i / N\Delta t$, and Δt is an arbitrarily chosen symbol duration of serial data sequence $x[i]$.

PAPR of an OFDM system is characterized using the Complementary Cumulative Distribution Function (CCDF).

Cumulative Distribution Function (CDF) is expressed as follows

$$F(Z) = 1 - e^{-Z} \quad (4)$$

Where z is probability of PAPR

Assuming that the sampling values of different sub-channels are mutually independent, and free of oversampling operation, the probability distribution function for PAPR less than a certain threshold value (Z), is therefore expressed as

$$P(PAPR < Z) = F(z)^N = (1 - e^{-z})^N \quad (5)$$

The Complementary Cumulative Distribution Function (CCDF) used to describe PAPR of OFDM system;

$$P(PAPR < Z) = 1 - F(z)^N = 1 - (1 - e^{-z})^N \quad (6)$$

The effect of oversampling is approximated by adding certain number of extra independent samples and oversampling factor ($L=4$) $\alpha = 2.8$ reach better PAPR value for $N > 64$;

The approximation is shown below,

$$P(PAPR > z) = F(z)^N = (1 - e^{-z})^{\alpha N} \quad (7)$$

The Conventional SLM Technique

Block diagram of Selective Mapping (SLM) technique is shown in figure 1. In this technique selecting a signal with lowest PAPR from a set of different signals representing the same information as the transmit signal [11-13]. Divide input data in to a X of length N then this data block is multiplied by distinct phase sequences, $B^{(u)} = [B^{(0)}, B^{(1)}, \dots, B^{(N-1)}]$, $u = 1, 2, \dots, U$, where $B_n^{(u)} = e^{j\phi_n^{(u)}}$ is the rotation factor, $n = 0 \dots N-1$, $\phi_n^{(u)}$ is uniformly distributed in $[0, 2\pi]$. After modulating OFDM frames are transformed into the time-domain using the IFFT and select one data sequence with lowest PAPR for transmission as it is depicted in table-I phase factor $[1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \ 1]$ produces minimum PAPR of 3.04 dB, so selection of phase factor is key point in reduction of PAPR.

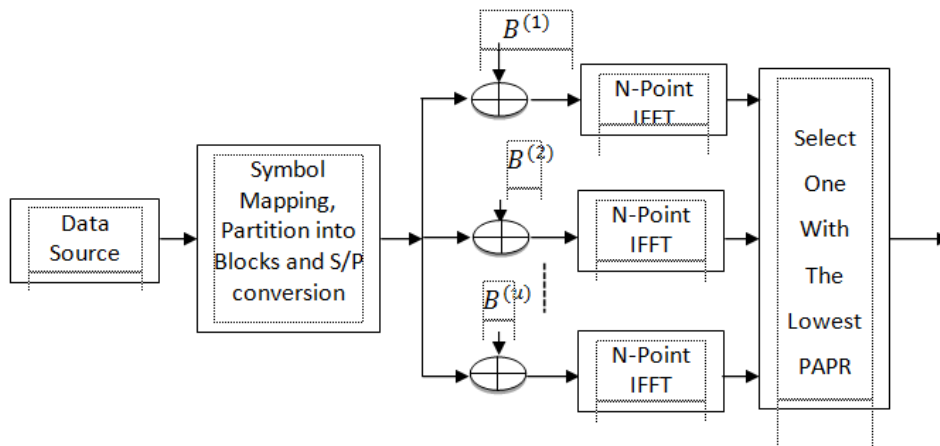


Figure 1: Block Diagram of OFDM Transmitter with the SLM Technique

We have carried out simulation experimentation using MATLAB communication tool box and by considering; 56 Number of sub-carriers, 256 No of IFFT's, QPSK/DQPSK Modulation scheme and μ -law compandrar for simulating conventional SLM and Modified SLM.

Table 1: Conventionalslm Modelsimulink Results

S. No.	Type of Modulation	Phase Factor	PAPR
1	BPSK	$[1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1]'$	9.031
2	BPSK	$[-1 \ -1 \ 1 \ 1 \ 1 \ 1 \ 1 \ -1]'$	4.465
3	BPSK	$[-1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \ 1]'$	6.532
4	BPSK	$[1 \ 1 \ -1 \ 1 \ 1 \ -1 \ 1 \ 1]'$	3.01
5	BPSK	$[-1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1 \ -1]'$	9.031
6	BPSK	$[-1 \ -1 \ -1 \ -1 \ 1 \ 1 \ 1 \ 1]'$	5.333
7	BPSK	$[1 \ 1 \ 1 \ 1 \ -1 \ -1 \ -1 \ -1]'$	5.333

HYBRID TECHNIQUE

Combination of modified SLM and μ -Law compandrar achieves better PAPR reduction as compared all other techniques, interconnection of system blocks are shown in figure 2. In the companding technique compression of OFDM signals done at the transmitter and expansion at the receiver side, compression given by;

$$y = V \frac{\log\left(1 + \mu \frac{|x|}{V}\right)}{\log(1 + \mu)} \text{sign}(x)$$

(8)

Where V is the peak amplitude of the input and output signals specified for the μ -Lawcomponder, and x is instantaneous amplitude of input signal. Decompression is simply the inverse of y [14-16].

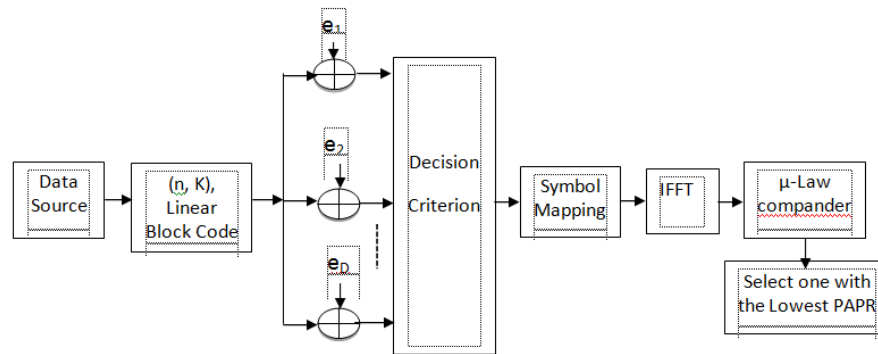


Figure 2 Block Diagram of the Hybrid Technique

The syndrome calculated [11] from received code word r is used for estimating the coset leader e chosen at the transmitter. The codeword c is obtained by calculating $e+r$ and then is converted into an information sequence of k bits [10-13].

RESULTS AND DISCUSSIONS

Figure 3 shows that MATLAB simulated CCDF curve for basic OFDM, constant SLM and Modified SLM, it is observed that significant PAPR reduction for MSLM and 0.1 dB reductions in PAPR for SLM with DPSK modulation as compared to SLM with QPSK scheme. It means selection of modulation scheme also important by which we can reduce small amount PAPR.

It is clear that for modified SLM technique PAPR reduction is approximately 50% as compared to basic OFDM PAPR and approximately 2dB PAPR reduction improvement as compared conventional SLM. And in figure 4 it is depicted combination of MSLM and companding techniques reduces PAPR at greater level.

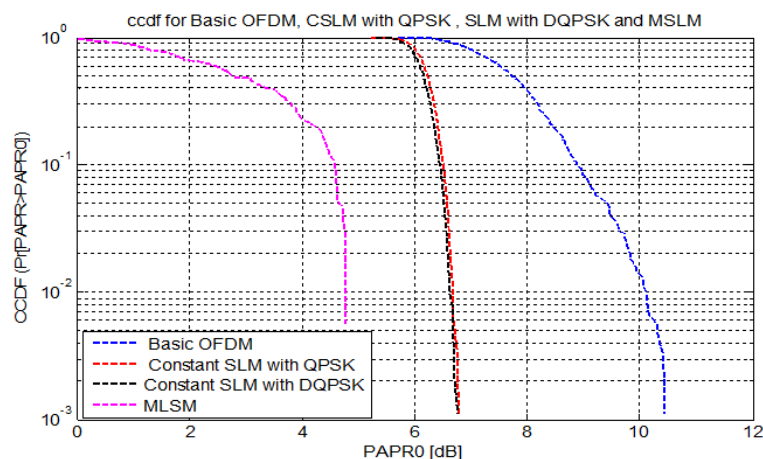


Figure 3: CCDF Curve for Conventional SLM, Modified SLM and MSLM

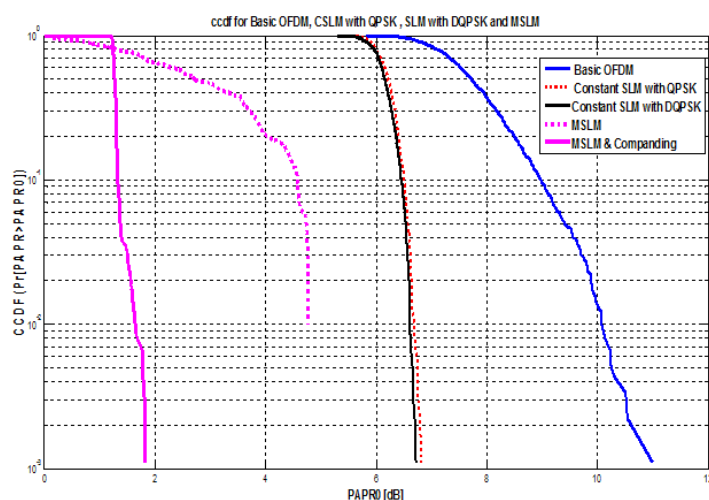


Figure 4: CCDF Curve for Conventional SLM, Modified SLM and MSLM with Companding

OBSERVATIONS

In above experimental simulations results shows, by MSLM PAPR is 4.5 dB, whereas after using companding technique along with MSLM PAPR is 1.8 dB, the proposed technique has good performance in reducing the PAPR of OFDM system key idea is concatenation of two techniques. And also improvement in PAPR by 0.1 dB with DQPSK as compared to QPSK for same simulation parameters. The choice of DQPSK is considered because simpler to implement than QPSK, since there is no need for demodulator to have a copy of the reference signal to determine the exact phase of the received signal. As it is a non-coherent scheme helpful to reduce complexity of system.

Figure 5, shows BER performance of OFDM system under AWGN channel. It is observed that BER performance of hybrid technique is worse than Block code and MSLM techniques.

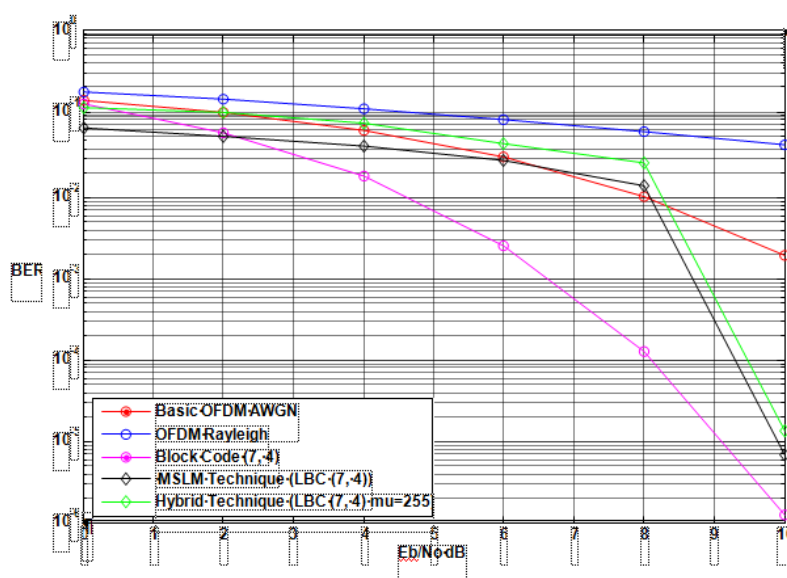


Figure 5: BER Performances of an OFDM System

CONCLUSIONS

In this paper Hybrid Technique is proposed which is combination of modified SLM and companding techniques, the MATLAB simulation results shows better reduction in PAPR. In comparison with SLM and Modified SLM, it is demonstrated that combination of MSLM and companding techniques results depicts greater reduction in PAPR than SLM techniques, but at the cost of BER.

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BIOGRAPHIES



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